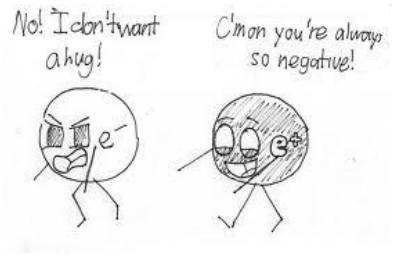


# Jumping Electrons!

Electrons can increase or decrease in energy level. When an electron changes energy level there is ALWAYS a release or absorption of energy. That energy will be in the form of electromagnetic radiation. A specific element will give off a specific group of wavelengths depending on the energy levels that are changing within the atom. Because of this, we may use emission spectra to identify specific elements.



You will use the site [www.wolframalpha.com](http://www.wolframalpha.com) to explore different spectra of various elements. Type in: "Hydrogen emission spectrum" to see the emission spectrum for Hydrogen. Use the same search for all other elements, "lithium emission spectrum" and so on...

1. Hydrogen's emission spectrum:

2. Oxygen's emission spectrum:

3. Neon's emission spectrum:

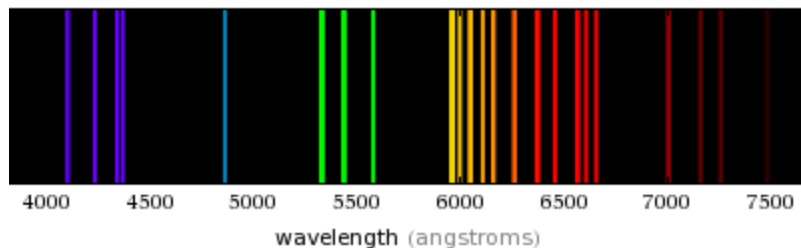
4. Carbon's emission spectrum:

5. Magnesium's emission spectrum:

## INVESTIGATION

The following emission spectrum was taken from a colorless odorless unknown liquid. It contains multiple elements (or in other words, it's a compound). Use the emission spectrum above to find the identity of the unknown compounds.

### 6. Unknown 1

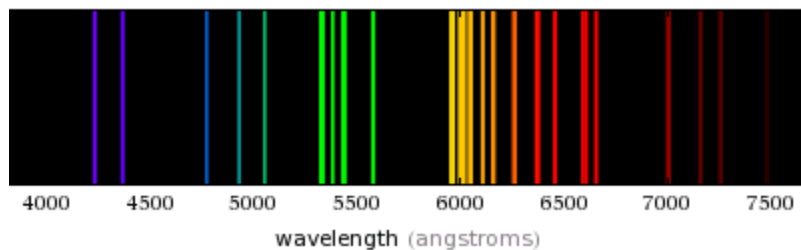


What elements are present?

How do you know that these are the elements present?

What compound do you think it could be?

### 7. Unknown 2



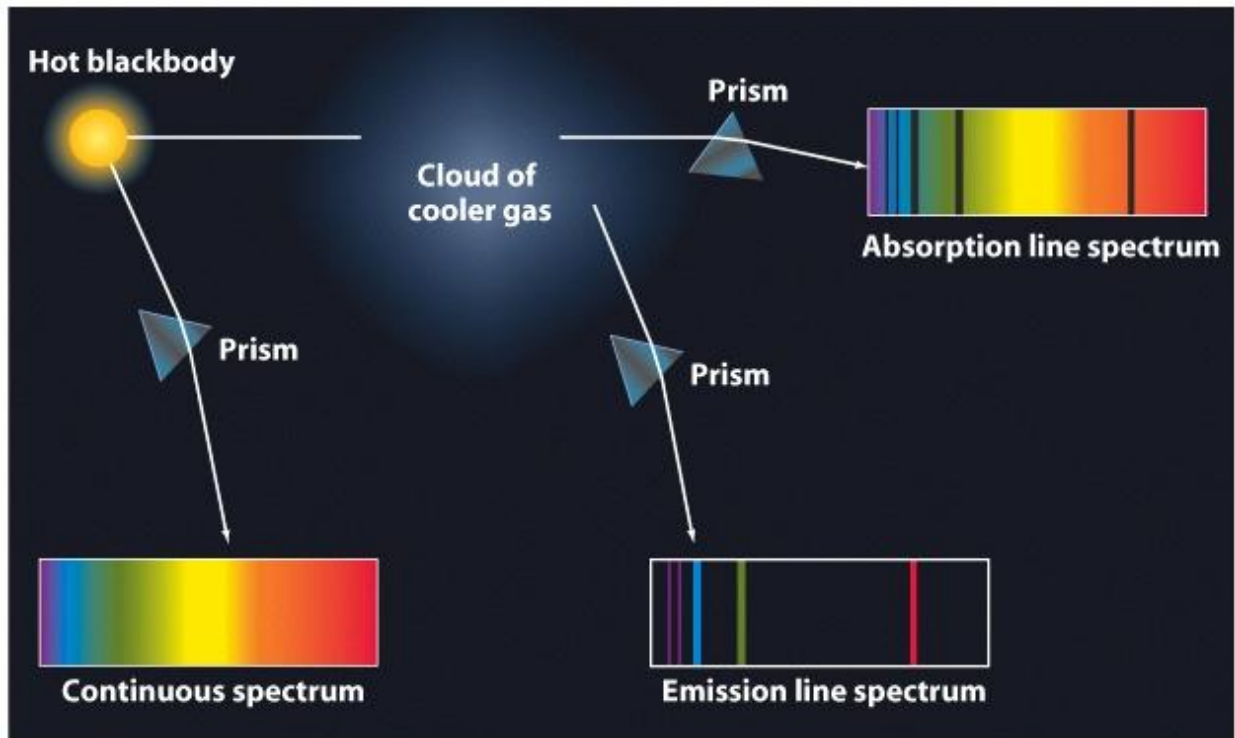
What elements are present?

How do you know that these are the elements present?

What compound do you think it could be?

8. Below is an emission spectrum from a far distant gas cloud.

a) What is the difference between the absorption spectrum and the emission spectrum?



b) Given this gas cloud below and its emission spectrum, what information could you determine? Defend your conclusion by including visual evidence from your investigation today.

9. Show the aufbau diagram for Neon:

When energy is added to the electron cloud, one electron will gain energy and leave its normal position into a higher energy level. Show an aufbau diagram for a Neon atom with one of the electrons boosted into the 3s orbital. (it will still have ten electrons, but the 2p will not be full).

Why do elements release electromagnetic radiation?

10. There are also non-visible wavelengths of light, just like there are sounds at frequencies that you cannot hear. In a way, we are all colorblind to colors that are beyond the ranges shown above (past red and violet).

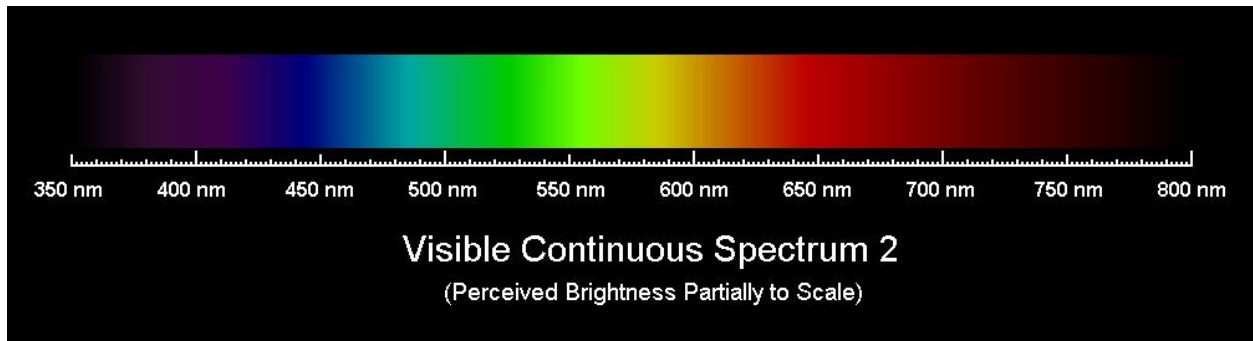
i. Search the electromagnetic spectrum.

ii. List the different types from lowest energy to highest energy

iii. Compare your spectrum with another student to confirm that you have all the types. Check with your instructor afterward.

11. Draw a model of a wave and label the wavelength, frequency, crest, and trough.

The energy that is absorbed or released is in the form of electromagnetic waves. Some of these waves are visible and some not. The visible ones may be easily measured and analyzed. The visible spectrum of light is found between 350nm and 800nm as seen below.



Frequency is inversely related to wavelength as follows:

$$c = \nu \lambda$$

$\nu$  = frequency (Hz)

$\lambda$  = wavelength (m)

$c$  = speed of light =  $2.998 \times 10^8$  m/s

Also, the energy of a wave can be found with this equation

$$E = h \nu$$

$E$  = energy (J)

$\nu$  = frequency (Hz)

$h$  = Planck's constant =  $6.626 \times 10^{-34}$  kg m<sup>2</sup>/s

12. If the frequency of a light wave is  $4.54 \times 10^{14}$  Hz, what is the wavelength?

13. If the wavelength of a light wave is 623nm, what is its frequency?

14. An FM radio station broadcasts at 93.1 MHz ( $9.31 \times 10^7$ Hz). What is the wavelength of one of these waves?

15. Nickel(II) has one green band on its spectrum.

Measure its wavelength and calculate its frequency. The wavelength is given in angstroms which 1 Angstrom =  $10^{-10}$  meters

16. If the frequency of a light wave is  $2.25 \times 10^{15}$ , what is the energy of the light wave?

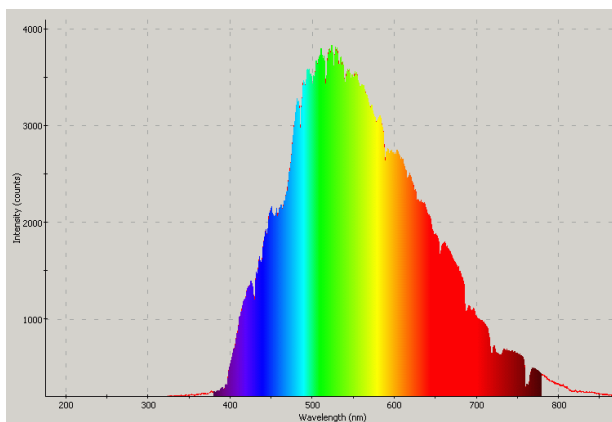
17. Paste the emission spectrum for copper:

List the spectral lines' wavelengths from shortest to longest

Find the energy of the shortest wavelength and the longest wavelength

18. Which of the following wavelengths of light has the largest energy? Red @ 650nm, Green @ 550nm, or Blue @ 450nm.

## 19. GRAPHING ANALYSIS



Above is a spectrographic analysis of the sun's rays. What color is the sun, and why are there bumps in these graphs? What color is most intense?

20. On the right is a table referring to NMR resonance. It's basically the same as electron emission, except the protons' spins are being measured. Use the chart on the right to identify the bonds represented in each chart below. Could you identify the number of bonds based on the chart?

carbon environment	chemical shift (ppm)
C-C	0 - 50
C-O	50 - 100
C=C	100 - 150
C=O	150 - 200

